
Emergency department presentations for injuries associated with inflatable amusement structures, Canada, 1990–2009

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Abstract

Introduction: Inflatable amusement attractions, structures that are air-supported and inflated by a blower, have recently gained popularity. The purpose of this study was to describe the epidemiology of inflatable-related injuries presenting to Canadian emergency departments.

Methods: The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is an injury and poisoning surveillance system presently operating in the emergency departments of all 11 pediatric and 4 general hospitals across Canada. The CHIRPP was searched for cases of injuries associated with commercial inflatable amusement structures.

Results: Overall, 674 cases were identified over the 20-year surveillance period, during which time the average annual percent increase was 24.6% (95% CI: 21.6, 27.7). Children aged 2 to 9 years were the most frequently injured (59.3/100 000 CHIRPP cases), and fractures accounted for 34.5% of all injuries.

Discussion: A sharp increase in emergency department visits for injuries associated with commercial inflatable amusement structures has been observed in recent years. Injury mechanisms could be mitigated by product design modifications and stricter business operational practices.

Keywords: injury prevention, injury surveillance, inflatable, CHIRPP, product safety

Introduction

Inflatable amusement attractions, that is, structures that are inflated and supported by a blower, have gained popularity in recent years. “Inflatables” come in a variety of shapes and sizes but can be classified into five broad categories: bounce houses, slides, interactive attractions (wrestling, boxing, bungee), obstacle courses, and climbing walls.¹ From an economic perspective, this is a potentially lucrative business opportunity due to the low initial investment on start-up and the growing demand.¹ Standards exist at both the international and national levels;²⁻⁴

however, except in Australia, these standards are not enforced by law. In Canada, only the electrical blower is under the jurisdiction of the Standards Council of Canada. The norm governing children’s play spaces and equipment (CAN/CSA-Z614-07) is not applicable to inflatable play structures.⁵

The Consumer Product Safety Commission (CPSC) has reported an increase in injuries related to inflatable amusement attractions in the United States. About 1300 cases (non-occupational) occurred in 1997, and 4900 in 2004.⁶ This number was subsequently

revised to 6101 in that year, and increased to 8348 cases in 2007, according to a CPSC memorandum.⁷ The most recent study using the same data source provided further refinements to the count and rate estimates for the period 1990 to 2010.⁸ In that study, there was a 15-fold increase in the number and rate of injuries between 1995 and 2010, with 11 311 incidents estimated for 2010.⁸ In addition, the CPSC is aware of 8 non-occupational fatalities involving inflatables between 2001 and 2007.^{1,7} Apart from the CPSC surveillance reports, the literature on injuries associated with inflatables in other countries, including Canada, is sparse.⁹⁻¹⁹

The industry is also growing in Canada, and more than 100 companies that rent inflatables were listed in the Yellow Pages (www.Yellowpages.ca), a national online business directory, in December 2011. A historical search using the Google Canada search engine (www.Google.ca) for webpages containing “rental” (“inflatable” OR “bouncy”) show a sharp increase since 2008. Apart from one reported death,^{1,20} studies on injuries associated with inflatable play structures in Canada are lacking. As two of its main goals, Canada’s principal injury surveillance system, the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP),²¹ identifies trends in product-related injuries and poisonings and provides detailed circumstances surrounding the injury event to inform injury prevention and mitigation programs.

The purpose of this study was to describe the epidemiology and characterize the temporal trend of Canadian emergency

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department presentations for injuries related to inflatable amusement structures among children and youth.

Methods

Data source

The CHIRPP is an injury and poisoning surveillance system that gathers information from the emergency departments of all 11 pediatric and 4 general hospitals across Canada.^{21,22} In operation since 1990, the CHIRPP system runs on an Oracle platform and currently contains about 2.2 million records (injury events). When an injured person or the accompanying parent or caregiver presents to an emergency department that is a CHIRPP site, hospital staff ask them to complete one side of a CHIRPP data collection form and the staff subsequently fill out the reverse side with clinical data. The information collected includes activity at the time of injury, activity leading to the injury, the direct cause of the injury, contributing factors, time and place of the injury event, the patient's age and sex, up to 3 injuries (body part and nature of injury) and the treatment received in the emergency department. Narrative fields provide information to further refine the coding and identify rare events and consumer products. All collected data are reviewed by the CHIRPP site co-ordinator for any missing information. Completed forms are sent to the Public Health Agency of Canada in Ottawa for entry by a trained coding team. Although only select hospitals report to CHIRPP, previous research has shown that the data collected through the program represent general injury patterns among Canadian youth.²³ Previous investigations have also reported on other methodological aspects of CHIRPP.²⁴⁻²⁸

Case selection

In October 2011, we conducted a search of the CHIRPP database for injuries related to inflatable play structures that had occurred between 1990 and 2009 (ages 0–18 years; 1 775 633 total records searched). Cases were selected (1) if any of the six contributing factor code fields contained the code for amusement rides and structures

(CHIRPP code 610), and (2) if the narrative fields (*Injury Event Description, Product, Place*) contained any of the following text strings: “INFLAT,” “AIR CASTLE,” “BOUNCY CASTLE,” “GONFLABLE” or “MOON WALKER.” Since the injury patterns associated with the smaller units intended for home use are likely to be different and the focus of this study was on large commercial devices, we reviewed all case narratives individually and initially separated records by location, retaining incidents occurring at fairgrounds, arenas, public parks, malls, parking lots, commercial recreational areas (indoor or outdoor) or on school grounds or in school gymnasiums (as part of a “family day” or “orientation day”). Incidents that took place at a private home or where the location was unknown were retained only if the narrative fields indicated that the inflatable play structure was a day rental (for a birthday party, for instance). Other exclusions included inflatable mattresses and inflatable toys (including small inflatable “bouncy houses” designed for indoor use).

Statistics and data analysis

Since CHIRPP is not population-based, data are presented in terms of proportions rather than strict counts. Age, sex, and year counts were normalized to the total numbers in the database (presented as the number per 100 000 CHIRPP cases in the given age group, sex or year) according to the following expressions:

$$\text{Normalized age – sex proportion} = \left(\frac{n_{\text{age,sex}}^{\text{inflatable}}}{N_{\text{age,sex}}^{\text{CHIRPP}}} \right) \times 100\,000$$

where $n_{\text{age,sex}}^{\text{inflatable}}$ is the number of inflatable-related cases for the given age group and sex, and $N_{\text{age,sex}}^{\text{CHIRPP}}$ is the total number of cases in CHIRPP for the same age group and sex.

$$\text{Normalized annual proportion} =$$

$$\left(\frac{n_{\text{year}}^{\text{inflatable}}}{N_{\text{year}}^{\text{CHIRPP}}} \right) \times 100\,000$$

where $n_{\text{year}}^{\text{inflatable}}$ is the number of inflatable-related cases for the given year, and $N_{\text{year}}^{\text{CHIRPP}}$ is the total number of cases in CHIRPP for the same year.

Year-to-year variations, likely due to small sample sizes, were smoothed by applying

a 5-point central moving average (CMA) to the normalized proportions.²⁹

Temporal trends in the normalized annual proportions were examined in two ways: the average annual percent change (AAPC) in the normalized proportion for the overall period (1990–2009) and for the most recent 10-year period (2000–2009) were calculated with 95% confidence intervals (CI) using the expression:

$$AAPC = [e^{\beta} - 1] \times 100$$

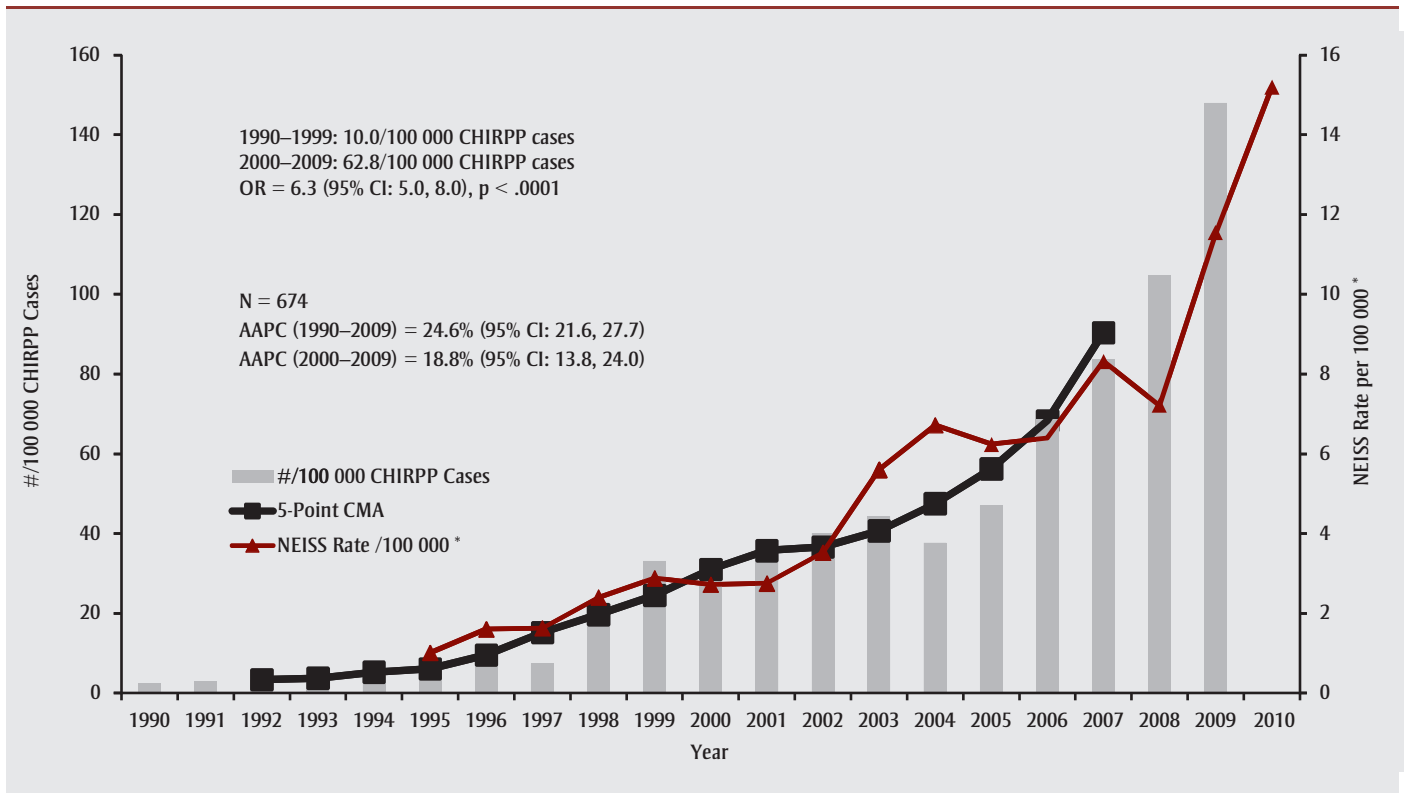
where β is the slope from a regression of log normalized proportion on year. The data were also separated into two 10-year time blocks and analyzed for period-to-period trends (χ^2 test, $p < .005$). Other results are presented in conventional descriptive format. All analyses were performed using the statistical software SAS version 9.2 (SAS Institute Inc., Cary, NC, US) and Microsoft Excel 2007 (Redmond, WA, US).

Results

Of the 674 CHIRPP cases identified over the 20-year period, 2 were occupational; in both these cases, the employees (boys, 15 and 17 years old) fell from the structure. Figure 1 shows the annual trend-normalized proportion by year for the period 1990 to 2009. Data from the U.S.⁸ is included for comparison. The normalized proportion shows an exponential increase ($R^2 = 0.95$ for the logarithmically transformed data). The proportion of patients presenting to emergency departments for inflatable-related injuries has risen sharply in recent years, with 46% of the cases occurring between 2007 and 2009. Overall, there has been an average annual increase of 24.6% (95% CI: 21.6–27.7), and in the most recent 10-year period, the average increase was 18.8% (95% CI: 13.8–24.0). From 1990 to 1999, there were 10.0 cases per 100 000 CHIRPP cases of all types. This proportion has increased 6-fold to 62.8 cases per 100 000 CHIRPP cases in the period from 2000 to 2009 ($p < .0001$).

Figure 2 details the normalized age and sex proportion. Children aged 5 to 9 years, both male and female, were the most frequently injured (57.2/100 000 and 74.6/100 000, respectively). Although

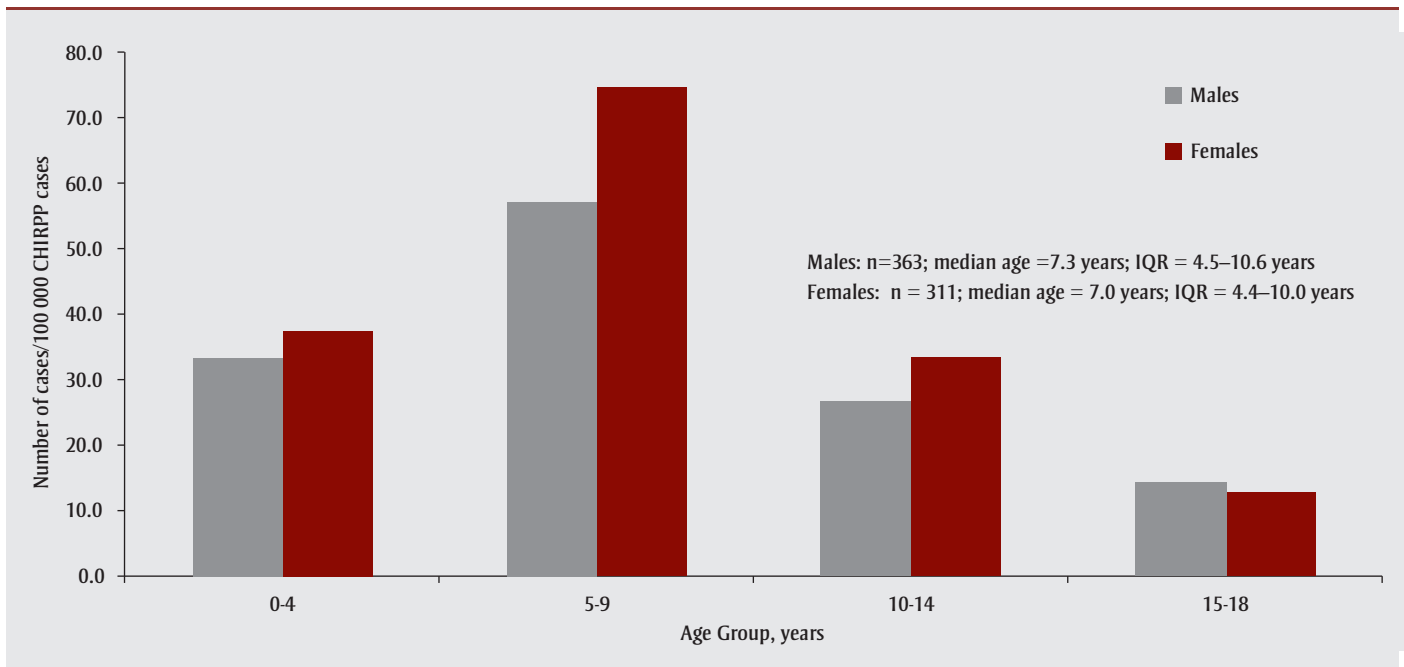
FIGURE 1
Injuries associated with inflatable play structures, normalized annual trend, CHIRPP, 1990–2009, ages 0–18 years



*Source: National Electronic Injury Surveillance System (NEISS). U.S. Consumer Product Safety Commission.⁸

Abbreviations: CI, confidence interval; AAPC, average annual percent change; CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program; CMA, central moving average; NEISS, National Electronic Injury Surveillance System.

FIGURE 2
Injuries associated with inflatable play structures, normalized age and sex distribution, CHIRPP, 1990–2009



Abbreviation: IQR, interquartile range.

TABLE 1
Epidemiology of injuries (n = 695) associated with inflatable amusement structures, CHIRPP, 1990–2009, ages 0–18 years

Characteristic	Cases (n = 674),	
	n	%
Location		
Public space ^a	412	61.1
School ^b	103	15.3
Private home ^c	97	14.4
Unknown ^d	62	9.2
Category of inflatable		
Bouncy house ^e	501	74.3
Slide	135	20.0
Obstacle course ^f	28	4.2
Unknown	10	1.5
Mechanism		
Bad landing	264	39.2
Ejection ^g	211	31.3
Impact with other person ^h	119	17.7
Attempting somersault	28	4.1
Body part caught ⁱ	23	3.4
Structure deflated	15	2.2
Structure collapse due to wind ^j	1	0.2
Unknown	13	1.9
Treatment in emergency department		
Left without being seen	11	1.6
Advice only ^k	154	22.8
Treated, follow-up if necessary	227	33.7
Treated, medical follow-up required	229	34.0
Held for prolonged observation in emergency	22	3.3
Admitted to hospital	31	4.6

Abbreviation: CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program.

^a Includes fairgrounds, arenas, public parks, malls, parking lots, commercial recreational areas (indoors or outdoors).

^b On school grounds or in the school gymnasium as part of a school “family day” or “orientation day.”

^c Includes only cases where the inflatable was a day rental of a commercial structure that was installed in the back or front yard of the residence.

^d Includes only cases where the narratives provided enough information to reasonably assume that the inflatable structure was a commercial type (e.g. “many kids jumping on a very large inflatable bouncy castle at a birthday party”).

^e Designed for multiple children jumping at the same time and commonly called “bouncy castle,” “air castle,” “inflatable trampoline,” “jump house” or “moon walker.”

^f Obstacle course, i.e. can be a hybrid structure for climbing, jumping and sliding.

^g Patient was ejected from the structure (either by bouncing or falling out, after being pushed by another person or upon disembarking) and landed on the ground or floor or struck a fixed object.

^h Child or adult (excluding ejection cases).

ⁱ Body part caught in part of structure (seams, support bars, flaps).

^j In this case, the patient was a bystander who was struck by the collapsing structure.

^k Includes diagnostic testing and referral to family doctor. No treatment received in emergency department.

males accounted for about 54% of all cases, when normalized for total numbers in the database, females were more frequent in every age group except in the 15- to 18-year age group.

Almost three-quarters of incidents occurred on a Friday, Saturday or Sunday (71%), and where the time of day was reported (n = 499), about 55% occurred between 1 p.m. and 5 p.m.

Incidents peaked in June (23.7%), and 70.2% occurred between June and September. Table 1 details the epidemiology of other variables. Just under two-thirds of the incidents occurred in public spaces such as fairgrounds, parking lots and other commercial recreational areas. Schools and private homes accounted for about 30%. Most of the structures involved were “jump houses” or “bouncy castles” (74.3%). Bad landings and ejections were the most common mechanisms of injuries, accounting for about 70% of incidents. Ejections were most common on slide structures, occurring in 61 of the 135 (45.2%) cases. Caught body parts occurred rarely, but of the 23 cases, 10 (43.5%) resulted in a fracture. Overall, the admission rate (which is a proxy for severity) was 4.6%; however, the rate was 7.1% for ejections and for those attempting somersaults.

Table 2 details the distribution of all 695 injuries sustained by the 674 patients between 1990 and 2009. Up to three injuries can be reported in CHIRPP; if there are more than three, the most serious two are reported and the third is recorded as multiple injuries. Overall, fractures represented over one-third (34.5%) of all injuries, and the lower extremity was the most frequently injured body region (40.3%). About 13% of all injuries were to the head and face, and of those, 48.9% were brain injuries (minor closed head injury, concussion) and 3.3% were fractures (skull/facial).

Discussion

Temporal trend

One of the purposes of the CHIRPP surveillance system is to provide timely data that allows the detection of emerging injury hazards. Figure 1 shows an exponential increase in injuries related to commercial inflatable amusement structures. Because CHIRPP data are numerator-based, a large portion of the increase in number of cases is likely due to increasing exposure. However, more hazardous inflatable designs, increases in reporting and changes in safety procedures could also account for some proportion of the increase. Figure 1 also shows rate esti-

TABLE 2
Injuries^a associated with inflatable amusement structures, CHIRPP, 1990–2009, ages 0–18 years

Injury ^a	Injuries, (n = 695)	
	n	%
Lower Extremity	280	40.3
<i>Fractures</i>	99	14.2
Tibia/fibula	35	
Foot, toes	28	
Ankle	27	
Femur	5	
Patella	4	
<i>Bruise, abrasion, soft tissue</i>	92	13.2
<i>Sprain, strain, dislocation</i>	84	12.1
<i>Lacerations</i>	5	0.7
Upper Extremity	238	34.2
<i>Fractures</i>	138	19.8
Elbow	47	
Forearm	46	
Wrist, hand, finger	26	
Humerus	14	
Clavicle	4	
Scapula	1	
<i>Sprain, strain, dislocation</i>	50	7.2
<i>Bruise, abrasion, soft tissue</i>	48	6.9
<i>Lacerations</i>	2	0.3
Head, Face, Neck	122	17.6
Brain ^b	45	
Facial bruise, abrasion, laceration, soft tissue	29	
Neck sprain/strain	21	
Eye, dental, scalp bruise, abrasion, laceration	15	
Neck bruise, abrasion, soft tissue	9	
Skull, facial fracture	3	
Spine, Cord, Trunk	36	5.2
Back bruise, abrasion, soft tissue	16	
Back sprain, strain	9	
Thoracic bruise, abrasion, soft tissue, laceration	8	
Pelvic bruise, abrasion, soft tissue	2	
Back – crushing injury	1	
Other	19	2.7
No injury detected	9	
Unknown	10	

Abbreviation: CHIRPP, Canadian Hospitals Injury Reporting and Prevention Program.

^a The CHIRPP records up to 3 injuries. Table 2 includes all injuries, i.e. 674 patients suffered 695 injuries.

^b Includes minor closed head injuries, concussions and intracranial injuries.

mates from the U.S. for 1990 to 2010.⁸ Although not directly comparable to CHIRPP proportions, these estimates are population-based and show a similar exponential trend ($R^2 = 0.94$ for the logarithmically transformed data). Also,

some of the earlier U.S. estimates showed very wide confidence intervals. The authors attributed the high variance to clustering of incidents: one of the hospitals in the sample is located near an inflatable amusement park and single

events often result in multiple injuries creating a cluster at the local hospital.⁷ However, all of these rates are just annual estimates based on the total population. The most informative denominator would be usage numbers (number of companies, average number of rentals and number of uses per rental, etc.). Such information has been difficult to determine in the U.S.,⁷ and we were unable to find any such information for the Canadian situation. Regardless, the increase shown in Figure 1 is important for injury prevention purposes.

Most inflatables are made overseas, in China, Hong Kong and the Philippines, and many of the manufacturers are not aware of international or Canadian standards. The costs of manufacturing inflatables also appear to be decreasing.¹ Given this, we may expect the current trend of increased availability to continue.

International literature

The literature on injuries associated with inflatable structures is not extensive. Table 3 summarizes all the studies (excluding case reports) currently available. Of these, the four from the U.S.^{1,7,8,13,16} had results most similar to ours with regard to the age range, temporal trend, proportion of all injuries that were fractures, and the proportion of injuries involving the head and face. The proportion of patients admitted to hospital was also similar (3.4%–4.0% vs. 4.6%), but this comparison must be interpreted with caution since jurisdictions have different admissions policies.

The type of inflatable involved in the incident was reported on in most studies. Sceviour¹ found that “bouncy castles” or “jump houses” were the type of inflatable in 96.7% of all incidents. Thompson et al.⁸ only included structures designed for jumping; slides not attached to a “jump house” were excluded. Our study used slightly different criteria and thus the distribution was somewhat different, with about three-quarters bouncy castles and one-fifth slides. Most of the other studies^{9–16,18} focussed specifically on jump houses or bouncy castles. In 1988, Olsen¹⁷ reported on an early form of bouncy castle

TABLE 3
Comparison of studies and reports describing injuries associated with inflatable amusement structures

Reference	Country	Study years	Number	Peak age group, year	Percent fractures, %	Percent admitted into hospital, %	Percent of injuries to the head/face, %
Sceviour, 2006 ¹	United States	1997–2004	18 554 ^a	3–11	33.5	N/A	N/A
Roegner, 2009 ⁷	United States	2003–2007	31 069 ^a	5–14	29.0	4.0	15.0
Thompson et al., 2012 ⁸	United States	1990–2010	64 657 ^a	6–12	27.5	3.4 ^b	27.8 ^c
Schwend, 2009 ^{13,d} Avoian et al., 2008 ^{16,d}	United States	2002–2007	49	7–9	100.0	N/A	0.0
Levene, 1992 ¹⁴	United Kingdom	N/A	105	5–14	5.7	1.9	N/A
Kirketerp-Moller et al., 1996 ¹⁵	Denmark	1993	91	N/A ^e	31.0	4.4	N/A
Olsen, 1988 ¹⁷	Denmark	1984–1985	78	11–16	31.0	9.0	1.3
O’Flynn and Cunningham, 2006 ¹⁸	Ireland	2006	13	N/A ^f	38.5	7.7	0.0
McFaull and Keays, 2013 (this current study)	Canada	1990–2009	674	2–9	34.5	4.6	13.2

Abbreviation: N/A, not applicable.

^a Weighted.

^b Includes those held for observation < 24 hours.

^c Includes concussion/closed head injury and face.

^d The studies by Schwend and Avoian et al. used the same data.

^e The studied range was 0–19 years. No distribution was provided.

^f The studied range was 3–15 years. No distribution was provided.

called “air cushions,” essentially giant pillows with no containment walls. Due to a large number of children jumping at the same time and the curvature of the structure, chaotic rebounding can be expected and trajectories difficult to calculate. As such, 70% of the incidents involved collision with another person. Most subsequent studies^{9–16,18} involved more modern structures. Healy et al.⁹ describe a case report of a 14-year-old girl with partial thickness friction burns on her knees and elbows, while our study had no cases of burns. McGuire et al.¹¹ reported on two cases of adult women sustaining cervical spinal fractures (hyperflexion mechanism) on a bouncy castle; in our data, trunk injuries accounted for 5.5% of all injuries and there was one spinal fracture and one dislocation. In 2008, Avoian et al.¹⁶ studied 49 cases of inflatable-related injuries at a Level 1 trauma centre in Los Angeles (CA). A sample of 21 families were contacted in a follow-up survey to gather more details regarding the injury event; all 21 cases involved rented inflatable bouncers at private homes and the mechanism of injury was collision with another child in 14 cases, ejection in 19 and a bad landing in 3.

Fatalities

Knowing the details of fatalities is useful for prevention purposes since many non-fatal cases may involve similar circumstances and could be considered as near-misses. Although CHIRPP is not a good source of mortality data (because emergency department data do not capture people who died before they could be taken to hospital or those who died after being admitted), and there were no fatalities in the present study, a number of deaths have been reported on internationally. In the U.S., the CPSC is aware of 8 non-occupational deaths involving inflatable amusement structures.^{1,7} Three occurred in 2001, 2 of which were suffocations involving a 2- and a 5-year-old; a 21-year-old man broke his neck while jumping in a bounce house in 2002; a 15-year-old male and an 18-year-old male fell from slides at school events in 2003 and 2004, respectively; a 24-year-old female fell from an inflatable climbing wall at an amusement site in 2005; and a 3-year-old was struck by two adults who fell through a gap in a “King of the Hill,” a large inflatable, in 2007. Three other deaths from outside of the U.S. have also been reported.^{1,19} In 2001, an 8-year-old

Australian girl was killed when she fell from an inflatable that was lifted 3 m from the ground by a sudden gust of wind.¹⁹ A similar case occurred in Budapest in 2007 when a child fell 27 m from an inflatable that was lifted up by a gust of wind.¹⁹ The only reported Canadian death (occupational) involved a 19-year-old male who died from head injuries after a fall from an inflatable climbing wall,^{1,20} though it is very possible that there have been other unreported deaths.⁶ A significant proportion of deaths and severe injuries involved those over 18 years of age. Because these age groups are under-represented in CHIRPP, they were not included in this study; nevertheless, we identified 15 cases when we did an initial search.

Trampolines

Comparing inflatables with trampolines is inevitable. In 2007, the Canadian Paediatric Society released a position statement regarding trampoline use in homes and playgrounds, and highlighted CHIRPP data (1990–2003) in that report.³⁰ Based on hospital admissions and percentages of fractures, injuries related to trampolines appear to be more serious. Trampoline-related injuries recorded in

CHIRPP have seen a sharp increase in recent years, similar to that associated with inflatables, and the Public Health Agency of Canada is currently undertaking an updated study of these injuries.

Injury prevention/mitigation

The results of this and other studies point to various areas for prevention.¹ Modifying product designs with respect to materials, structure height, openings and anchoring systems may help to mitigate certain types of injuries. Operators must be aware of weather conditions such as wind and rain that can facilitate falls from the structure. They will need to follow stricter guidelines to prevent overcrowding and equipment failure (electrical or otherwise), and attentive supervision should also be recommended. Although more data are needed, there is some suggestion that inflatable slides are more hazardous than bouncy castles: our study found there to be a higher proportion of falls (ejections) from slides than from bouncy castles. Slide structures often have less containment on the portions where users ascend. Finally, more research needs to be done to compare injury severity and mechanism in fixed-site versus mobile inflatables.

Limitations

This study has a number of limitations. It is important to note that the injuries described do not represent all injuries in Canada but only those seen at the emergency departments of the 15 hospitals in the CHIRPP network. Since most of the data come from the pediatric hospitals, which are in major cities, injuries suffered by adults and by older teenagers, who can also be seen at general hospitals, are under-represented in the CHIRPP database, as are those of people who live in rural and remote areas, including Aboriginal populations. Also, as previously mentioned, fatalities are also under-represented. Some very severe injuries may also be missed because the caregivers or the patient was not asked to fill out a form due to the severity of the injuries; unless the site co-ordinator goes back to the charts and fills out a CHIRPP form (in some hospitals this may not

always occur), the case will be missed. There is also the potential for misclassification of cases. In particular, the 162 cases (23.5%) that took place in private homes or unknown locations may not have been rented units but just smaller toy versions.

Conclusions

The number of injuries associated with commercial inflatable amusement structures appear to be increasing in Canada. Injury prevention efforts should focus on standards and operator error in order to halt this rise in injuries and prevent possible fatalities.

References

1. Sceviour J. Inflatable amusement ride safety. Worcester (MA): Worcester Polytechnic Institute; 2006.
2. Standard practice for design, manufacture, operation, and maintenance of inflatable amusement devices [Internet]. West Conshohocken (PA): ASTM International; 2010 [cited 2011 Dec 27]. ASTM F2374-10. Available from: <http://www.astm.org/Standards/F2374.htm>
3. British Standards Institution. Inflatable play equipment. Safety requirements and test methods. BS EN 14960:2006. London (UK): BSI; 2007.
4. Standards Australia. New standard for jumping castles and other inflatable amusement rides [Internet]. 2005 Dec [cited 2011 Dec 27]. Available from: <http://www.standards.org.au/SearchandBuyAStandard/Pages/default.aspx>
5. Canadian Standards Association. CAN/CSA-Z614-07 - Children's playspaces and equipment. Mississauga [ON]: CSA; 2007.
6. Levenson MS. Amusement ride-related injuries and deaths in the United States: 2005 update [Internet]. Washington (DC): United States Consumer Product Safety Commission; 2005 [cited 2011 Dec 27]. Available from: <http://www.cpsc.gov/library/amus2005.pdf>
7. Roegner R. Memorandum. Estimated number of injuries and reported deaths associated with inflatable amusements, 2003-2007. Bethesda (MD): United States Consumer Product Safety Commission; 2009 Jul 10.

8. Thompson MC, Chounthirath T, Xiang H, Smith GA. Pediatric inflatable bouncer-related injuries in the United States, 1990-2010. *Pediatrics*. 2012;130:1076-83.
9. Healy C, Riordan C, Kelly JL. Bouncy castle burns. *Burns*. 2006; 32(7):920-1.
10. Kok KY, Chong CL. Injuries caused by inflatable bouncers. *Inj Extra*. 2005;36(11):496-8.
11. McGuire BB, Gul R, Kingston R, Synnott K. 'Bouncy castles' and cervical spine fractures: an under-recognized hazard. *Eur J Orthop Surg Tr*. 2006;16(2):154-5.
12. Singer G, Freedman LS. Injuries sustained on "bouncy castles". *BMJ*. 1992;304(6831):912.
13. Schwend RM. Inflatable bouncer injuries: another backyard worry. *AAP Grand Rounds*. 2009;21(1):10.
14. Levene S. More injuries from "bouncy castles". *BMJ*. 1992;304(6837):1311-2.
15. Kirketerp-Moller K, Balslev N, Lohmann M. [Accidents caused by inflatable bouncers in 0-19 year-olds in Denmark in 1993]. *Ugesk Laeger*. 1996;158(16):2251-3.
16. Avoian T, Choi PD, Manjra N, Weiss J. Inflatable bouncer-related fractures in children. *J Pediatr Orthop*. 2008;28(6):656-9.
17. Olsen PA. Injuries in children associated with trampolinelike air cushions. *J Pediatr Orthop*. 1988;8(4):458-60.
18. O'Flynn O, Cunningham K. Hard landings: injuries sustained on bouncy castles presenting to an emergency department in the north west of Ireland. Presented at: Proceedings of the 7th Annual Multidisciplinary Research Conference; 2006 Nov 24; Sligo General Hospital, Ireland.
19. Water M, Stokes M. Inflatable jumping castles: advocacy in action. *Inj Prev*. 2010;16(suppl 1):A191.
20. Teen dies after accident on inflatable ride [Internet]. 2000 news archive. 2000 May 31 [cited 2010 Oct 4]. Available from: <http://www.rideaccidents.com/2000.html#may31>

-
21. Mackenzie SG, Pless IB. CHIRPP: Canada's principal injury surveillance program. Canadian Hospitals Injury Reporting and Prevention Program. *Inj Prev.* 1999;5:208-13.
 22. Herbert M, Mackenzie SG. Injury surveillance in paediatric hospitals: the Canadian experience. *Paediatr Child Health.* 2004; 9(5):306-8.
 23. Pickett W, Brison RJ, Mackenzie SG, et al. Youth injury data in the Canadian Hospitals Injury Reporting and Prevention Program: do they represent the Canadian experience? *Inj Prev.* 2000;6(1):9-15.
 24. Macarthur C, Pless IB. Evaluation of the quality of an injury surveillance system. *Am J Epidemiol.* 1999;149(6):586-92.
 25. Macarthur C, Pless IB. Sensitivity and representativeness of a childhood injury surveillance system. *Inj Prev.* 1999; 5(3):214-6.
 26. Macarthur C, Dougherty G, Pless IB. Reliability and validity of proxy respondent information about childhood injury: an assessment of a Canadian surveillance system. *Am J Epidemiol.* 1997;145(9):834-41.
 27. Pless B. Surveillance alone is not the answer. *Inj Prev.* 2008;14(4):220-2.
 28. Macpherson AK, White HL, Mongeon S, et al. Examining the sensitivity of an injury surveillance program using population-based estimates. *Inj Prev.* 2008;14(4):262-5.
 29. Diggle PJ. Time series: a biostatistical introduction. New York: Oxford University Press; 1990.
 30. Purcell L, Philpott J; Canadian Paediatric Society. Position statement. Trampoline use in homes and playgrounds. *Paediatr Child Health.* 2007;12(6):501-5.